The Progression and Impact of Sleep Disordered Breathing in the Post-Discharge Phase of Acutely Decompensated Heart Failure

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An Undergraduate Honors Thesis

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25 May 2011

Acknowledgements

I would like to thank my advisors, Dr. Rami Khayat and Dr. Sarah Varekojis, for their guidance and immense support. Without them, this thesis would not be possible. Thank you to Dr. Khayat for his expertise and dedication. I am honored to have completed a research project under your tutelage. I appreciated the opportunity of engaging in the research process firsthand. To Dr. Sarah Varekojis for her encouragement and direction throughout this project. Despite the challenges, completing a thesis was less daunting with you as my advisor. I am grateful because if not for you, this research topic, less this thesis would not have been realized. I would also like to thank Brian Patt and Angela Sow from the Sleep Heart Program at the Ross Heart Hospital, as I could not have completed the data collection without resources and assistance.

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Abstract

The Progression and Impact of Sleep Disordered Breathing in Acutely Decompensated Heart Failure Post-Discharge

Background: Sleep disordered breathing (SDB) is prevalent in more than half of patients with stable heart failure (HF). The Ohio State University Medical Center (OSUMC) Ross Heart Hospital has implemented a surveillance program to identify and treat sleep disordered breathing (SDB) in patients admitted with acutely decompensated heart failure (ADHF). **Problem Statement:** No studies have examined SDB following treatment during ADHF admission in-hospital to outcomes post-discharge. **Purpose:** To evaluate the effectiveness and feasibility of the in-hospital screening program at the Ross Hospital and evaluate the course of SDB post-discharge for admittance of ADHF. **Methods:** Subjects were obtained from an existing database of sleep study reports for ADHF admittance between May and September 2010. Patients were contacted by mail with a Minnesota Living with Heart Failure (MLWHF) questionnaire and a letter of instruction. All received a phone call inquiring about their follow-up status as well as an educational session about SDB and their heart condition. Patients were also asked to complete the questionnaire over the phone if they did not mail their responses. Results: 105 patients qualified for the in-hospital screening. 17 (16%) were negative for SDB and 88 (84%) were positive for SDB. Patients negative for SDB scored a MLWHF mean of 23.50 and patients positive for SDB had a mean score of 35.98. Of the 105 patients, 70 (67%) confirmation letters of SDB diagnosis were sent. In a separate cohort of 36 patients identified with CSA in-hospital, 26 of 36 (77%) identified with CSA on repeat studies post-discharge with optimal medical therapy. **Conclusion:** This study confirms the high prevalence of SDB in ADHF. While this study showed no significance in quality of life between SDB cohorts, the difference may be clinically significant for post-discharge outcomes. Screening has greater implications of expedited treatment of SDB during ADHF hospitalizations.

Chapter I: Introduction

Heart failure (HF) is related to increasing incidence and steady related mortality with little improvement demonstrated over time [1, 2]. HF affects 5 million Americans and is the most common Medicare diagnosis upon discharge [3]. For 2010, the annual cost of HF was estimated to exceed $39.2 billion [4]. Utilization and hospitalization costs are notably higher in the elderly population presenting with acutely decompensated heart failure (ADHF) [3]. Hospital readmission rates remain high with almost 50% readmission within six months of discharge [5, 6]. While there have been promising advancements in pharmacologic practice guidelines, treatment options for ADHF still remain relatively unchanged [7]. Due to increasing morbidity, mortality and economic burdens associated with ADHF, it is imperative to study and address co-morbid factors as an adjunct to conventional treatments.

Sleep disordered breathing (SDB) is categorized into obstructive sleep apnea (OSA) and central sleep apnea (CSA). During OSA, collapsing of the pharyngeal airway causes increased negative intrathoracic pressure with cyclical episodes of intermittent hypoxia and surges of sympathetic activity [8, 9]. Increased activation of the sympathetic system in OSA is strongly associated with hypertension [10, 11]. The intermittent hypoxia pattern seen in OSA as well as CSA is linked to endothelial dysfunction and atherosclerosis [12]. Therefore it is likely that the cardiovascular consequences of OSA would worsen heart failure and may promote decompensation. The occurrence of CSA is predominantly specific to HF [13], where CSA presents with a cyclic pattern hypoventilation and hyperventilation known as Cheyne-Stokes respiration (CSA-CSR). The presence of CSA in heart failure patients is linked to worsened outcomes. This is likely due to mechanisms similar to those of OSA. Both sleep disorders are associated with the same pattern of intermittent hypoxia and sympathetic activation. The use of positive airway pressure (PAP) therapy for SDB in HF has shown positive effects on cardiac markers such as left ventricular function, blood pressure, and heart rate [14-17].

The Ohio State University Medical Center (OSUMC) Ross Heart Hospital has implemented a surveillance program to identify SDB in patients admitted with ADHF for better initiation of treatment. Earlier findings in this program showed improved left ventricular function within days of PAP therapy for SDB in-hospital [17]. An evaluation of this program's feasibility is essential for enhanced management of HF and has significant implications towards a standardization of

care for SDB in ADHF admissions. This project is designed to examine the impact of SDB on post-discharge outcomes in patients with ADHF.

Aim 1- To evaluate an in-hospital program for the diagnosis of SDB

1a- Determine feasibility of in-house screening program for patients with SDB.

- We would expect a high prevalence of OSA and CSA in patients screened for SDB in-hospital.

1b- Perform a quality program of an existing program tasked with screening hospitalized patients.

- We would expect a lack of follow-up post-discharge which would result in less patients on treatment for their SDB.
- We would expect patients with SDB to have a higher morbidity and poorer quality of life (higher questionnaire score) than patients negative for SDB.

Aim 2- To evaluate the natural course of CSA in the post-discharge period in patients admitted with ADHF.

- We would expect decreased central events in the post-discharge phase.

Chapter II: Literature Review

SDB is more common in HF patients than in the general middle-aged adult population [18] with several studies showing a high prevalence of both OSA (40-57%) and CSA (15-40%) [14, 19-21]. All of these studies were performed on stable heart failure subjects with varying cut-off criteria in the outpatient setting. OSA and CSA are associated with a similar profile of cardiovascular consequences that worsen heart failure. Both are associated with a pattern of intermittent hypoxia that results in sympathetic activation and increases in blood pressure [22] [23]. OSA exacerbates existing cardiovascular disease and increases associated cardiovascular events [24-26]. In hypertensive patients, OSA worsens blood pressure control [27, 28]. Patients with OSA have increased risk of developing atrial fibrillation [29, 30], and recurrence after cardioversion [30]. OSA also increases the risk of developing coronary artery disease (CAD) [31] and worsened outcomes [32, 33]. The cardiac consequences of OSA are most notably linked to sympathetic activation [34, 35] and are shown to negatively impact HF patients [36-38] by exacerbating hypertension[39, 40], CAD[41-43], and arrhythmia[44, 45]. These symptoms and conditions are known to cause acute HF [46]. Therefore, severe sympathetic activation would exacerbate existing heart failure and cause ADHF. Similarly, CSA is also associated with increased sympathetic activity and risk of cardiac arrhythmia [47]. Periodic breathing in CSA causes increased negative intrathoracic pressure, which affects afterload and subsequent

precipitation of pulmonary edema [48]. This has implications for worsening cardiac function and readmissions.

A recent study of Medicare beneficiaries with heart failure revealed that less than 4% are ever diagnosed with SDB and those who were screened earlier in their diagnosis showed better survival [49]. Coupled with current underutilization of SDB screening and subsequent treatment, a recent study of inpatients with ADHF showed 75% prevalence of SDB [50]. These studies emphasize the necessity and importance of an in-hospital screening program for expedited treatment of SDB in ADHF. Treatment of concurrent OSA in patients with heart failure carries promising positive impact on morbidity and mortality. The beneficial effects of PAP therapy in HF patients with OSA are well supported. Continuous positive airway pressure (CPAP) on patients with OSA and HF decreases nocturnal heart rate, systolic blood pressure and AHI [14]. Combined PAP therapy and medical therapy showed a significant improvement of LVEF compared to only medical therapy [15, 16].

Treatment of CSA with CPAP has also shown significant improvement in LVEF in CHF [51-53]. In one of the largest and longest studies of CSA and HF, there was an improvement in LVEF, norepinephrine levels, and six minute walk on treatment with PAP [51]. PAP therapy is likely to reverse symptoms[54]. Therefore, diagnosis and treatment of SDB is likely to improve the outcome of patients with heart failure. To date, there is no standard of practice for systematic approach to diagnosis and treatment of OSA in patients with stable HF, much less ADHF [55-57]. It is possible that patients with ADHF are more susceptible for the impact of SDB on their cardiac function [17]. No study has evaluated an inpatient screening program of ADHF or studied the impact of SDB on ADHF outcomes.

It is probable that the impact of SDB on HF is most pronounced in the immediate post-discharge phase. Within the first month, HF patients have six times the risk for sudden mortality and they experience high rehospitalization rates within the first six months [1, 6]. Untreated OSA in HF demonstrates higher mortality than patients treated for SDB [49, 58]. To date, no evaluation exists regarding the impact of SDB on HF related symptoms in the post-discharge phase. The appropriate methods and sample size for such an evaluation have not been establishedCSA severity and prevalence may correlate with HF [47, 59]. CSA may be a consequence of heart failure [59] linked with increased chemosensitivity to CO_2 [60] and pulmonary congestion [47]. Patients with heart failure may manifest a mixed sleep disorder with features of both OSA and

CSA. Visualizations of modeled central events demonstrated obstructive components with central events [61]. Therefore, it is possible that CSA events will decrease with optimal management of heart failure in the post-discharge phase [62].The treatment for CSA and OSA is accomplished by different positive pressure devices in the outpatient setting. It is important to differentiate components of SDB in the inpatient setting and confirm the persistence of CSA in the outpatient setting.

Chapter III: Methodology

Data was obtained from portable sleep studies performed at the OSUMC Ross Heart Hospital for ADHF admission between May and September 2010. Admitted patients met the following eligibility requirements: a diagnosis of congestive heart failure and elevated left ventricular pressure as indicated by at least one sign and one symptom of volume overload (pedal edema, crackles, consistent chest X-ray, increased left ventricular end-diastolic dimension (LVEDD), or elevated B-type natriutic peptide (BNP) level. All patients had previously unidentified sleep apnea with an AHI $\geq$ 15 events per hour and received treatment for heart failure that included IV diuretics, IV infusion of inotropes, vasodilators, planned revascularization, or device therapy. Conventional scoring mechanisms were utilized to determine patients' risks for SDB. In addition to verbal confirmation of their SDB status, patients received a letter post-discharge of whether they were positive or negative for SDB with instructions and options for follow-up. Additionally, a separate CSA cohort was reviewed for a sensitivity comparison of in-patient sleep tests and out-patient overnight polysomnography test (PSG).

Study Protocols

Subjects were identified from an ongoing database of sleep study reports for ADHF admissions. All patients were initially contacted via mail with a Minneosta Living with Heart Failure (MLWHF) Questionnaire (Appendix A) and a letter of instruction. MLWHF questionnaire has been validated to describe the impact of HF severity on quality of life [63-67]. In multiple randomized controlled trials of pharmacological interventions in HF, the MLWHF questionnaire improved from 3-12 points over periods of three to six months, thus reflecting effectiveness of the intervention [67-69].

Upon completion of the questionnaire, patients were encouraged to contact the office for further follow-up of results. Phone calls followed an algorithm of triage (Appendix B) dependent on the results of their initial sleep study, follow-up status and questionnaire completion. If patients

screened positive for SDB on their initial sleep test and expressed no follow-up for sleep apnea since discharge, they received an educational session about the risks of SDB and their heart failure along with the importance of a PSG. If no questionnaire was received, the questionnaire was administered over the phone. For patients who were unreachable, at least two attempts were made to contact the patient.

A separate cohort of patients was identified in-hospital with CSA between 2007 and 2010. All patients received an in-patient sleep study and a repeat study post-discharge. We compared both studies for sensitivity of in-patient and out-patient screening.

Statistical Analysis

Descriptive statistics such as means, medians, and ranges were used to characterize patient demographic data. Frequencies were utilized to determine the most common reasons for unreachable patients and lack of follow-up. T-tests were used to identify significance of SDB cohort characteristics and questionnaire scores.

Chapter IV: Article

Introduction

Heart failure (HF) continues to have high increasing incidence and steady related mortality with little improvement [1, 2]. HF affects 5 million Americans and is the most common Medicare diagnosis upon discharge [3]. For 2010, the annual cost of HF was estimated to exceed $39.2 billion [4]. Utilization and hospitalization costs are notably higher in the elderly population presenting with acutely decompensated heart failure (ADHF) [3]. Hospital readmission rates remain high with almost 50% readmission within six months of discharge [5, 6]. While there have been promising advancements in pharmacologic practice guidelines, treatment options for ADHF still remain relatively unchanged [7]. Due to increasing morbidity, mortality and economic burdens associated with ADHF, it is imperative to study and address co-morbid factors as an adjunct to conventional treatments.

Sleep disordered breathing (SDB) is categorized into obstructive sleep apnea (OSA) and central sleep apnea (CSA). SDB is more common in HF patients than in the general middle-aged adult population [18] with several studies showing a high prevalence of both OSA (40-57%) and CSA (15-40%) [14, 19-21]. OSA and CSA are associated with a similar profile of cardiovascular consequences that worsen heart failure. CSA severity and prevalence may correlate with HF

[47, 59]. CSA may be a consequence of heart failure [59] linked with increased chemosensitivity to CO_2 [60] and pulmonary congestion [47]. Both sleep disorders are associated with the same pattern of intermittent hypoxia and sympathetic activation. The use of positive airway pressure (PAP) therapy for SDB in HF has shown positive effects on cardiac markers such as left ventricular function, blood pressure, and heart rate [14-17]. Treatment for CSA and OSA is accomplished by different positive pressure devices in outpatients. Therefore it is important to differentiate components of SDB in the inpatient setting and confirm the persistence of CSA in the outpatient setting.

A recent study of Medicare beneficiaries with heart failure revealed that less than 4% are ever diagnosed with SDB and those who were screened earlier in their diagnosis showed better survival [49]. Coupled with current underutilization of SDB screening and subsequent treatment, a recent study of inpatients with ADHF showed 75% prevalence of SDB [50]. These studies emphasize the necessity and importance of an in-hospital screening program for expedited treatment of SDB in ADHF.

The Ohio State University Medical Center (OSUMC) Ross Heart Hospital has implemented a surveillance program to identify SDB in patients admitted with ADHF for better initiation of treatment. Earlier findings in this program showed improved left ventricular function within days of PAP therapy for SDB in-hospital [17]. An evaluation of this program's feasibility and effectiveness is essential for enhanced management of HF and has significant implications towards a standardization of care for SDB in ADHF admissions. This project is designed to examine the impact of SDB on post-discharge outcomes in patients with ADHF. No study has evaluated an inpatient screening program of ADHF or studied the impact of SDB on ADHF outcomes.

Methodology

Data was obtained from portable sleep studies performed at the OSUMC Ross Heart Hospital for ADHF admission between May and September 2010. Admitted patients met the following eligibility requirements: a diagnosis of congestive heart failure and elevated left ventricular pressure as indicated by at least one sign and one symptom of volume overload (pedal edema, crackles, consistent chest X-ray, increased left ventricular end-diastolic dimension (LVEDD), or elevated B-type natriuretic peptide (BNP) level. All patients had previously unidentified sleep apnea with an AHI $\geq$ 15 events per hour and received treatment for heart failure that included IV

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A separate cohort of patients was identified in-hospital with CSA between 2007 and 2010. All patients received an in-patient sleep study and a repeat study post-discharge. We compared both studies for sensitivity of in-patient and out-patient screening.

Statistical Analysis

Descriptive statistics such as means, medians, and ranges were used to characterize patient demographic data. Frequencies were utilized to determine the most common reasons for unreachable patients and lack of follow-up. T-tests were used to identify significance of SDB cohort characteristics and questionnaire scores.

Results

Patient Characteristics

105 patients qualified for the in-hospital screening between May and September 2010. The breakdown was as follows: 25 females (23.8%), 80 males (76.2%) from 25-86 years of age and a mean ejection fraction (EF) of 34%. Of these patients screened in-hospital, 17 (16%) were negative for SDB and 88 (84%) were positive for SDB. See Table 1 for a detailed breakdown for SDB prevalence. During the evaluation, 10 passed away and two were excluded due to incarceration. Of the remaining 93 patients, 62 were successfully contacted by the researcher via phone (Figure 1). The most common reasons for not reaching patients were due to disconnected or out-of-service phone numbers or the patient was unavailable at the time of the call.

Follow-up

A retrospective analysis of the conformation letter indicated 70 (67%) documented letters were mailed to patients. Of those reached by phone, 20 (32%) indicated follow-up either with their cardiologist, primary care provider, and or with a PSG (Figure 1). The most common reasons for lack of follow-ups were pending appointments or disinterest. Seven stated that they were currently on treatment for SDB. While 93 patients were mailed questionnaires, we received 61 MLWHF questionnaires in the mail and over the phone. Some patients mailed in their questionnaires but could not be reached due to unserviceable phone numbers. There was no significant difference in age (p value= .469), AHI (p value= .227), and BMI (p value= .126) of responders and non-responders of the MLWHF questionnaire (Table 2). Those who were negative for SDB had a mean MLWHF score of 23.5 (n=11) while patients with SDB had a mean MLWHF score of 36 (n=50). There was no significance (p value = .218) between response scores (Table 3).

Central Sleep Apnea

Between 2007 and 2010, 36 patients were initially identified with CSA in-hospital. Of these patients, 26 (77%) were identified with CSA on repeat studies six months average post-discharge. 8 were identified with OSA and 2 were negative for SDB.

Discussion

To date, no study has reviewed an in-patient program tasked to identify SDB in ADHF with outcomes post-discharge. Between May and September 2010, 84% of the 105 patients

screened in-hospital tested positive for SDB. Of those patients with SDB, the majority demonstrated predominantly OSA (62%) with a minority of CSA (13%) and mix of both central and obstructive events (1%). This supports the results of Khayat et al [50] in which 75% of hospitalized patients demonstrated SDB as well as Paulino et al who found 81% prevalence of SDB in the same population [70]. An earlier study by Javaheri [20] found that 40% of heart failure patients had CSA and 11% had OSA. Sin et al [71] also found a similar break down of SDB categories. Both authors evaluated predominantly elderly male populations. More recent studies [19-21, 71] have demonstrated a predominance of OSA compared to CSA. OSA is highly prevalent in the non-heart failure population and its predominance in the heart failure may be explained by aging and increased BMI in these patients [71]. Earlier findings of in-hospital screening revealed that patients screened for OSA during hospitalization were 100% predictive of having OSA on repeat outpatient studies [50]. The presence of CSA may be related to the severity of HF [47], and is rarely seen outside of heart failure population. Treatment of heart failure improves but does not eliminate CSA [62].Therefore, it is important to determine whether having CSA in the inpatient setting correlates with persistence of this disorder in the outpatient setting.

Currently little is known about follow-up and treatment for SDB from the in-patient to out-patient setting. Despite a 60% response by phone and questionnaire, there was no difference in age, BMI, or AHI between responders and non-responders. A retrospective analysis of initial SDB letters notes a 67% correspondence with discharged patients and subsequent follow-up of 32% three to six months post-discharge. While not all patients were initially contacted with their SDB status, it remains unclear as to whether the patients themselves were aware of their risks for SDB despite notification by letter. Modifications are needed to improve the efficiency of follow-up in this program. Patient follow-up may include barriers such as no insurance or insufficient patient education regarding the consequences of SDB and its implications for their heart failure.

In terms of quality of life in the post-discharge phase, there was no statistically significant difference ($p = .218$) in mean MLWHF scores between patients positive and negative for SDB. A lack of statistical significance may have been due to a small sample size and does not rule out a clinically significant difference of 12.48 points between SDB groups. The presence of comorbidities such as periodic limb movements and depression may explain a wide range in scores, particularly in the negative SDB group. This may have resulted in an elevation of questionnaire scores due to the effects of their comorbidities on their daily living instead of their

HF. Patients were not screened for these conditions and were not excluded in the overall analysis.

Despite optimal medical therapy for HF, this study demonstrated a 76% prevalence of CSA on repeat sleep studies more than six months post-discharge. CSA is rationalized as a consequence of HF severity [48] with worsening congestion and pulmonary capillary wedge pressure [47]. A study by Tamura et al [72] showed that the use of beta-blockers decreased central events. Similarly, Solin et al found that treatment of heart failure with diuresis can decrease the number of central events [47]. Therefore with optimized medical therapy, the prevalence of CSA was thought to decline in the outpatient phase with proper management. These findings support the notion that new treatment guidelines for heart failure has resulted in decreased prevalence of CSA. Secondly, the persistence of CSA has shown that CSA diagnoses in-hospital is a chronic disease state that can be targeted with specific interventions. This has further implications for individualized treatment and management of CSA in the outpatient setting.

In conclusion, this study confirms a high prevalence of SDB in patients hospitalized for ADHF. While there was no statistically significant difference between mean MLWHF scores, patients with SDB trended towards worsened quality of life. A larger sample is needed to detect differences in quality of life between SDB cohorts. While only two thirds of patients in this program were notified of their SDB diagnosis post-discharge, this contrasts a 4% diagnosis rate in a large cohort of Medicare beneficiaries [49]. More importantly, this study supports the necessity of surveillance programs for screening and expedited treatment of SDB in ADHF.

Chapter V: Discussion & Conclusion

According to a recent study by Javaheri et al [49] only 4% of medicare patients with newly diagnosed HF were suspected of SDB and only 2% received screening. The current state of screening and treatment for SDB in HF remains underutilized despite a high prevalence of SDB in this population [19-21, 71]. Compared nationally, 32% of patients screened by the program indicated follow-up post-discharge. Correspondence with patients could be improved with increased support and resources for a systematic implementation of communication and follow-up. Services such as appointment scheduling prior to discharge or phone calls post-discharge would encourage patients to follow-up and seek treatment. Patient education may also improve follow-up by offering educational materials in-hospital. Therefore, patients will be more informed

of the health consequences related to SDB and the importance of addressing this in the outpatient setting.

The use of the MLWHF questionnaire could be administered to larger samples to determine a difference in patients' quality of life with and without SDB. However, these tools are potentially misleading due to comordibities such as periodic limb movements and depression. These comobidities may alter patients' responses of their day-to-day experiences. Exclusion criteria should be further defined to account for these conditions. The evaluation could be extended to include additional markers such as readmission and six-minute walk. These markers may supplement questionnaire responses and provide a more detailed description of quality of life in HF.

Earlier findings of in-hospital treatment for SDB has shown improvement of LVEF within days of using PAP therapy [17]. This has further implications for immediate treatment in the hospital setting. Dependent on the SDB type, patients would receive different PAP therapy devices immediately after screening. Previous studies have demonstrated the persistence of OSA in-hospital and in the outpatient setting [17, 19-21, 71]. Additionally, this study has also demonstrated a persistence of CSA from in-hospital to post-discharge. The continued persistence of OSA and CSA could have greater implications for treatment initiation in-hospital as well as an evaluation of post-discharge outcomes.

In summary, this study confirms a high prevalence of SDB in hospitalized patients for ADHF and is the first study that has evaluated an in-patient screening program with outcomes post-discharge. There was no statistical significance between mean MLWHF scores; however, patients with SDB trended towards worsened quality of life. A larger sample is needed to detect differences in quality of life between SDB cohorts. Less than one third of patients indicated follow-up, which suggests modifications in the program for improved correspondence and patient education. While only two thirds of patients were notified of their SDB diagnosis six months post-discharge; this compares to a recently reported 4% diagnosis rate [49]. Despite on optimal medical treatment, a retrospective analysis of a separate CSA cohort demonstrated a continued persistence of central events post-discharge. Most importantly, this study supports the necessity of surveillance programs for screening and expedited treatment of SDB in ADHF.

Appendix A: Minnesota Living with Heart Failure Questionnaire

Please indicate if you are receiving treatment for sleep apnea Yes_____No_____

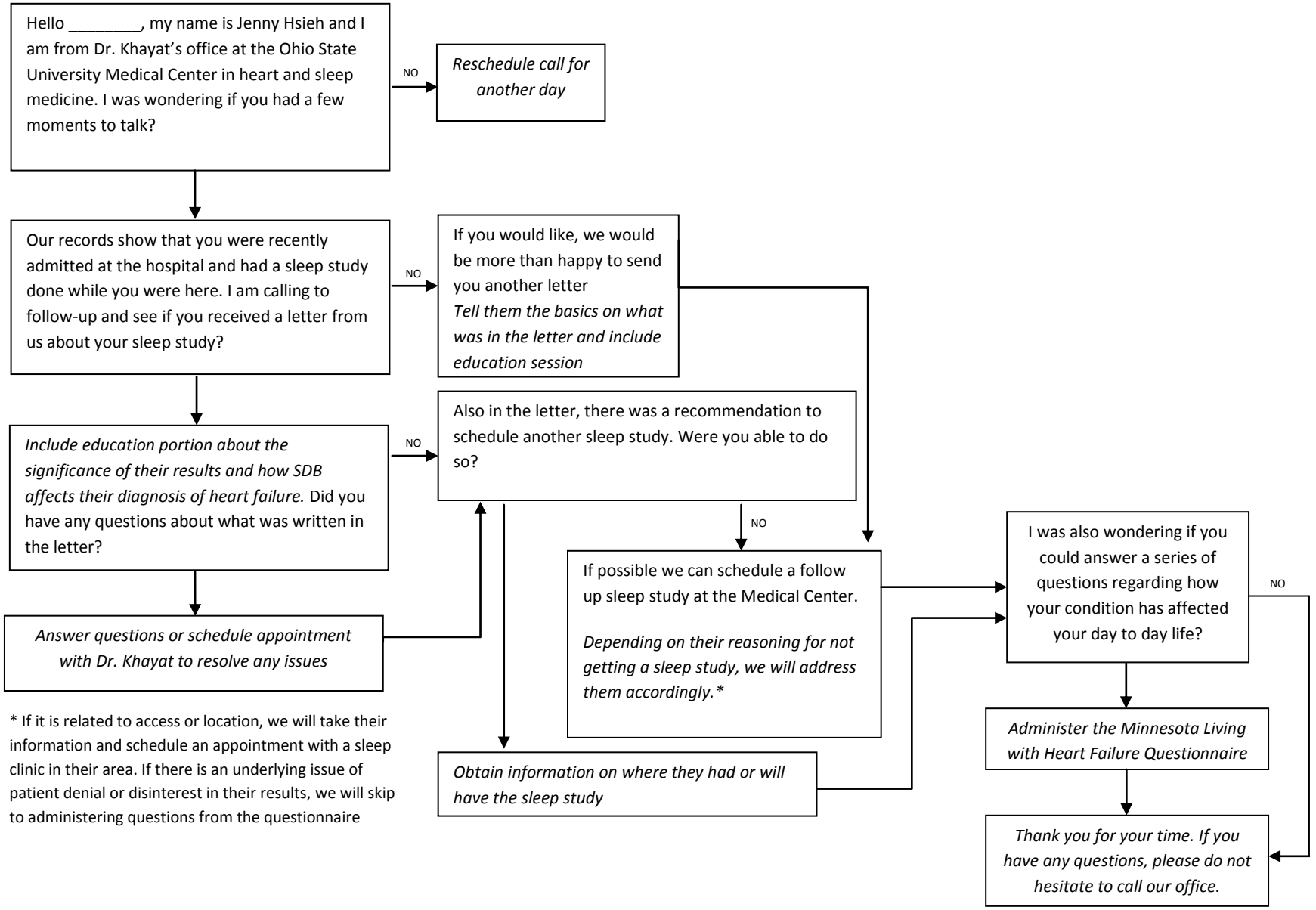
These questions[1] concern how your heart condition has prevented you from living as you wanted **during the last month**. The items listed below describe different ways some people are affected. If you are not sure an item does not apply to you or is not related to your heart condition, then circle 0 (No) and go on to the next item. If an item does apply to you, then circle the number rating how much it prevented you from living as you wanted.

Did your heart condition prevent you from living as you wanted **during the last month** by:

	No	**Very Little**				**Very Much**
1. Causing swelling in your ankles, legs, etc.?	0	1	2	3	4	5
2. Making you sit or lie down to rest during the day?	0	1	2	3	4	5
3. Making your walking about or climbing stairs difficult?	0	1	2	3	4	5
4. Making your working around the house or yard difficult?	0	1	2	3	4	5
5. Making your going places away from home difficult?	0	1	2	3	4	5
6. Making your sleeping well at night difficult?	0	1	2	3	4	5
7. Making your relating to or doing things with your friends or family difficult?	0	1	2	3	4	5
8. Making your working to earn a living difficult?	0	1	2	3	4	5
9. Making your recreational pastimes, sports, or hobbies difficult?	0	1	2	3	4	5
10. Making your sexual activities difficult?	0	1	2	3	4	5
11. Making you eat less of the foods you like?	0	1	2	3	4	5
12. Making you short of breath?	0	1	2	3	4	5
13. Making you tired, fatigued, or low on energy?	0	1	2	3	4	5
14. Making you stay in a hospital?	0	1	2	3	4	5
15. Costing you money for medical care?	0	1	2	3	4	5
16. Giving you side effects from medication?	0	1	2	3	4	5
17. Making you feel you are a burden to your family or friends?	0	1	2	3	4	5
18. Making you feel a loss of self-control in your life?	0	1	2	3	4	5
19. Making you worry?	0	1	2	3	4	5
20. Making it difficult for you to concentrate or remember things?	0	1	2	3	4	5
21. Making you feel depressed?	0	1	2	3	4	5

[1] Minnesota Living with Heart Failure™ Questionnaire © University of Minnesota 1986, Reproduced with permission.

Appendix B: Phone Call Algorithm



* If it is related to access or location, we will take their information and schedule an appointment with a sleep clinic in their area. If there is an underlying issue of patient denial or disinterest in their results, we will skip to administering questions from the questionnaire

Table 1: Prevalence of Sleep Disordered Breathing in Acutely Decompensated Heart Failure

Type of Sleep Disordered Breathing	# out of 105 sleep studies (%)
OSA	65 (61.9%)
CSA	14 (13.3%)
Mixed	4 (.9%)
None	17 (16.2%)
SDB*	5 (4.7%)

(*Due to lack of effort belt during the study, scoring result only indicated SDB)

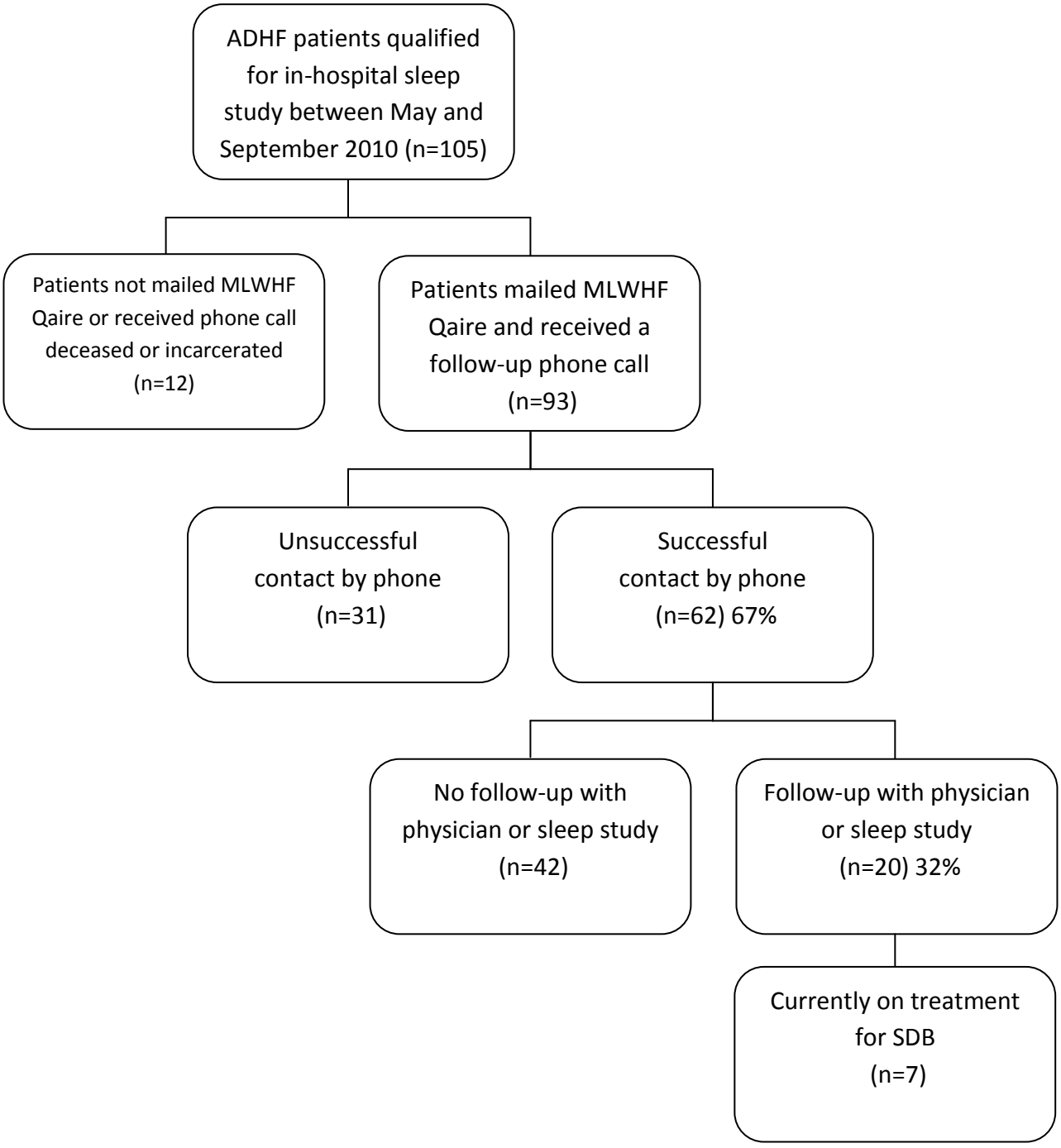
Table 2: Comparison of patient characteristics of Responders vs Non-Responders of the MLWHF Questionnaire

Characteristics	Responders	Non-Responders	P-Value
Age	61.3 $\pm$ 14.27	59.3 $\pm$ 12.97	.469
AHI	31.5 $\pm$ 20.86	36.4 $\pm$ 19.78	.227
BMI (kg/m^2)	30.6 $\pm$ 7.43	33.4 $\pm$ 10.28	.126

Table 3: Characteristics of Patients based on SDB

Characteristics (n = 105)	Positive SDB 84% (n = 88)	Negative SDB 16% (n = 17)	P-Value
Age	60.5 $\pm$ 13.8	60.0 $\pm$ 15.05	.873
EF	33.3 $\pm$ 15.15	39.35 $\pm$ 14.19	.130
AHI	38.5 $\pm$ 18.37	7.7 $\pm$ 6.29	.000
BMI (kg/m^2)	31.93 $\pm$ 8.98	30.94 $\pm$ 8.13	.675
MLWHF Score	35.98 $\pm$ 23.34	23.50 $\pm$ 29.91	.218

Figure 1: Follow-up



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